WHAT IS CLAIMED IS:

1. A semiconductor position-sensitive radiation detection device, comprising:

   a substrate formed of a semiconductor material doped to exhibit a first conductivity type and configured to have first and second surfaces opposing each other, the substrate having (1) a transparent conducting bias electrode layer formed over the first surface and in electrical contact thereto and (2) an array of doped gate regions of a second conductivity type on the second surface; and

   a grid of conducting wires formed over and in electrical contact with the conducting bias electrode layer or back contact layer on the first surface and configured to define an array of pixels corresponding to the array of doped regions;

   wherein the grid of conducting wires is connected to distribute a common potential on the transparent conducting bias electrode layer so as to bias the substrate with respect to the doped regions to effect a photodiode array that receives radiation from the first surface.

2. The device as in claim 1, wherein the transparent conducting bias electrode layer is internal to the substrate and is formed by doping a layer of the substrate near the first surface to exhibit the first conductivity type.

3. The device as in claim 1, wherein the transparent conducting bias electrode layer is external to the substrate and is formed from a transparent conductor layer externally attached to the first surface.

4. The device as in claim 3, wherein the transparent back contact layer includes a heavily-doped polycrystalline layer of a semiconductor material that forms the substrate.

5. The device as in claim 1, wherein the transparent conducting bias electrode layer includes a first layer external to the substrate and formed from a transparent conductor layer externally attached to the first surface and a second layer internal to the substrate

and formed by doping a layer of the substrate near the first surface to exhibit the first conductivity type.

6. The device as in claim 1, further comprising a circuit layer formed over the second surface to provide a gate contact to and a readout circuit for each doped region,

7. The device as in claim 1, further comprising a scintillation array of scintillation elements formed in a scintillator crystal operable to convert incident radiation at a spectral range outside the characteristic spectral response range of the substrate into secondary photons at a second wavelength within the spectral response range of the substrate, said scintillation array being coupled to the grid of conducting wires on the first surface of the substrate, wherein the scintillation elements match the size of and are aligned with the photodiodes of the photodiode array defined by the grid of conducting wires and the scintillation array includes optically reflective surfaces disposed between the scintillation elements to optically isolate one scintillation element from another.

8. The device as in claim 7, wherein one of the first and second conductivity types is caused by n-type dopants and the other is caused by p-type dopants.

9. The device as in claim 7, wherein the substrate includes silicon.

10. The device as in claim 7, wherein the transparent conducting bias electrode layer is internal to the substrate and includes a heavily-doped crystalline layer.

11. The device as in claim 7, wherein the grid of conducting wires is formed of a metallic material.

12. The device as in claim 11, wherein the metallic material includes aluminum.

13. The device as in claim 7, further comprising an anti-reflection layer formed over the transparent conducting layer within each pixel and configured to reduce reflection of photons incident on the first surface.

14. The device as in claim 13, wherein the anti-reflection layer is electrically insulating.

15. The device as in claim 13, wherein the anti-reflection layer includes a dielectric layer having a refractive index that has a relation with a refractive index of the transparent conducting layer.

16. The device as in claim 1, wherein one of the first and second conductivity types is caused by n-type dopants and the other is caused by p-type dopants.

17. The device as in claim 1, wherein the substrate includes silicon.

18. The device as in claim 7, further comprising an anti-reflection layer formed over the transparent conducting layer within each pixel and configured to reduce reflection of photons incident on the first surface.

19. A semiconductor position-sensitive radiation detection device, comprising:

array of photodiodes formed in a substrate having a first surface and a second surface opposing the first surface, wherein the first surface is electrically conducting to provide a common bias potential to the photodiodes and is optically transparent to receive input photons to be detected; and

grid of conducting wires formed over and in electrical contact with the first surface and configured to define an array of pixels corresponding to the array of photodiodes, wherein the grid of conducting wires is connected to distribute a common potential to the photodiodes.

20. The device as in claim 19, further comprising a scintillation array of scintillation elements formed in a scintillator crystal operable to convert incident radiation at a

first wavelength outside the characteristic spectral response range of the photodiodes into secondary photons at a second wavelength within the spectral response range of the substrate and coupled to the grid of conducting wires on the first surface of the substrate, wherein the scintillation elements match, and are aligned with, the pixels defined by the grid of conducting wires and the scintillation array includes optically reflective surfaces disposed between the scintillation elements to optically isolate one scintillation element from another.

21. The device as in claim 20, further incorporating an anti-reflection layer formed over the first surface within each pixel and configured to reduce reflection of photons incident to the first surface.

22. The device as in claim 21, wherein the anti-reflection layer is electrically insulating.

23. The device as in claim 21, wherein the anti-reflection layer includes a dielectric layer having a refractive index that has a relation with a refractive index of the first surface.

24. The device as in claim 19, further incorporating an anti-reflection layer formed over the first surface within each pixel and configured to reduce reflection of photons incident to the first surface.

25. The device as in claim 19, further comprising a circuit layer formed over the second surface to provide a gate contact to and, if provided, a readout circuit for each photodiode,

26. The device as in claim 19, wherein the conductivity of the first surface is formed by doping a layer of the substrate near the first surface to exhibit the same conductivity as the substrate.

27. The device as in claim 19, wherein the conductivity of the first surface the transparent is formed from a transparent conductor layer externally attached to the first surface.

28. The device as in claim 27, wherein the transparent conductor layer includes a heavily-doped polycrystalline layer of a semiconductor material that forms the substrate.